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TITLE: Networked system for interactive communications and remote monitoring
of drug delivery

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The present invention relates generally to communication systems for remote
monitoring of patients, and in particular to a networked system for remotely monitoring patients and for communicating information to the patients through
the use of script programs. The invention further relates to a patient monitoring and drug delivery measurement system for measuring and electronically recording measurements of drug dose(s) administered to a patient. The invention also relates to injection syringes adapted for use with a dose measurement apparatus for electronically recording drug delivery measurements.

Typically, these injections are performed using disposable syringes. Unfortunately, no adequate apparatus exists that measures and electronically
records dose information from a disposable syringe. As a result, the patient or health care worker performing the injection is burdened with the task of injecting the dose and then manually recording the dose amount in a logbook.

The recorder described by Beckers does not automatically measure and record
dose information from a disposable syringe. After injecting a dose, the

patient must manually enter the dose information into the recorder using switches or keys. Although this is an improvement over keeping written records
on paper, the effectiveness of the drug program is still limited by the patient's recollections and recordings, which are unreliable.

Although the syringe pump described by Sanderson does allow electronic recording of dose information, it is only designed to deliver medication directly into an intravenous line. It is not designed to inject a patient directly nor can it measure and record a dose from a syringe unless the syringe
pump pushes the plunger. Consequently, the syringe pump is of little use to a
health care worker who must inject a patient directly, or to an outpatient who
must follow a self-injection treatment program.

Although the injection pen described by Muller measures and electronically records dose information, it has several injection pen is an expensive device requiring complicated electronic equipment to deliver and record doses. Moreover, because the injection pen integrates a syringe and electronic recorder into one device, it is not disposable. The patient must use it repeatedly for each injection, even after the injection pen has been contaminated with blood. Consequently, the injection pen does not provide an
inexpensive, convenient, or hygienic solution to patients wishing to measure and electronically record injected dose information.

Operating the device described by Claeys requires many complicated steps of
weighing syringes, scanning in bar codes, etc. The complexity of the required
procedures, as well as the high cost of the apparatus, have precluded its widespread use. Additionally, the device cannot be easily carried by the user
for recording doses while away from the health care facility or home. Thus, no

inexpensive apparatus exists for determining and electronically recording dose
information from a disposable syringe. Further, no such apparatus exists that
is both simple in operation and easily carried by a user.

If the detector detects light transmitted or emitted by the syringe, the detector is situated opposite the light source relative to the syringe. If the detector detects light reflected by the syringe, the detector is situated adjacent the light source relative to the syringe (on the same side of the syringe).

FIG. 31B illustrates generally the principal detection step performed by measurement apparatus 428" of the present invention. Light (electromagnetic
radiation) is incident on syringe 580" and interacts with syringe 580". Light resulting from the interaction is then incident on detector 450 (FIG. 31A). The light incident on detector 450 may generally be light transmitted, reflected, and/or emitted by syringe 580". In general, two elements of syringe
580" may vary with the quantity of liquid within syringe 580" in a typical dose
administration sequence: i) the position of the syringe plunger (relative to the syringe barrel), and ii) the quantity/position of the liquid within syringe 580". Light incident on syringe 580" may interact with the plunger and/or liquid. The measured light interaction with the plunger is preferably substantially different from the interaction with the liquid, such that the interaction with syringe 580" as a whole depends on at least one of the position of the plunger and the quantity of liquid.

FIG. 34 shows a perspective view of another embodiment of the present invention. An apparatus 1528 includes a holding means 1552 for holding the
barrel of a syringe 1580 in a predetermined position relative to a measurement
window 1503. Syringe 1580 includes a plunger 1590 having a longitudinally

varying marking 1591. Marking 1591 is desirably a color marking, but generally
may be a shape marking. A light source and detector (both not shown) are situated behind measurement window 1503, for reading the part of marking 1591
in alignment with window 1503. Light emitted by the light source is reflected
by marking 1591 back into the detector. The reflected light (its intensity and/or spatial distribution) is indicative of the position of marking 1591 relative to window 1503, which is in turn indicative of the quantity of liquid within syringe 1580. The quantity of liquid within syringe 1580 is in turn indicative of a dose delivered from syringe 1580.

An optical method of dose measurement does not require the presence of a plunger to transmit, reflect or absorb light. A method of the present invention may be used to optically measure liquid levels in plungerless syringes operated using air pressure, for example.